



0300  
WY  
I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail on MAY 14, 2001 in an envelope addressed to:  
Assistant Commissioner for Patents, Washington, D.C. 20231

Date 5/14/01 Sig: Marjorie Scariati  
Name: Marjorie Scariati

**IN THE UNITED STATES PATENT & TRADEMARK OFFICE**

**APPLICANT(S):** Richard Anthony Cox et al.

**SERIAL NO.:** 09/774,157

**FILING DATE:** January 29, 2001

**TITLE:** AIR CONTENT DETERMINATION

**ART UNIT:** Unassigned

**EXAMINER:** Unassigned

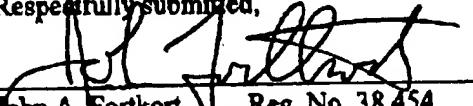
**DOCKET:** 7000/1

Assistant Commissioner for Patents  
Washington, DC 20231

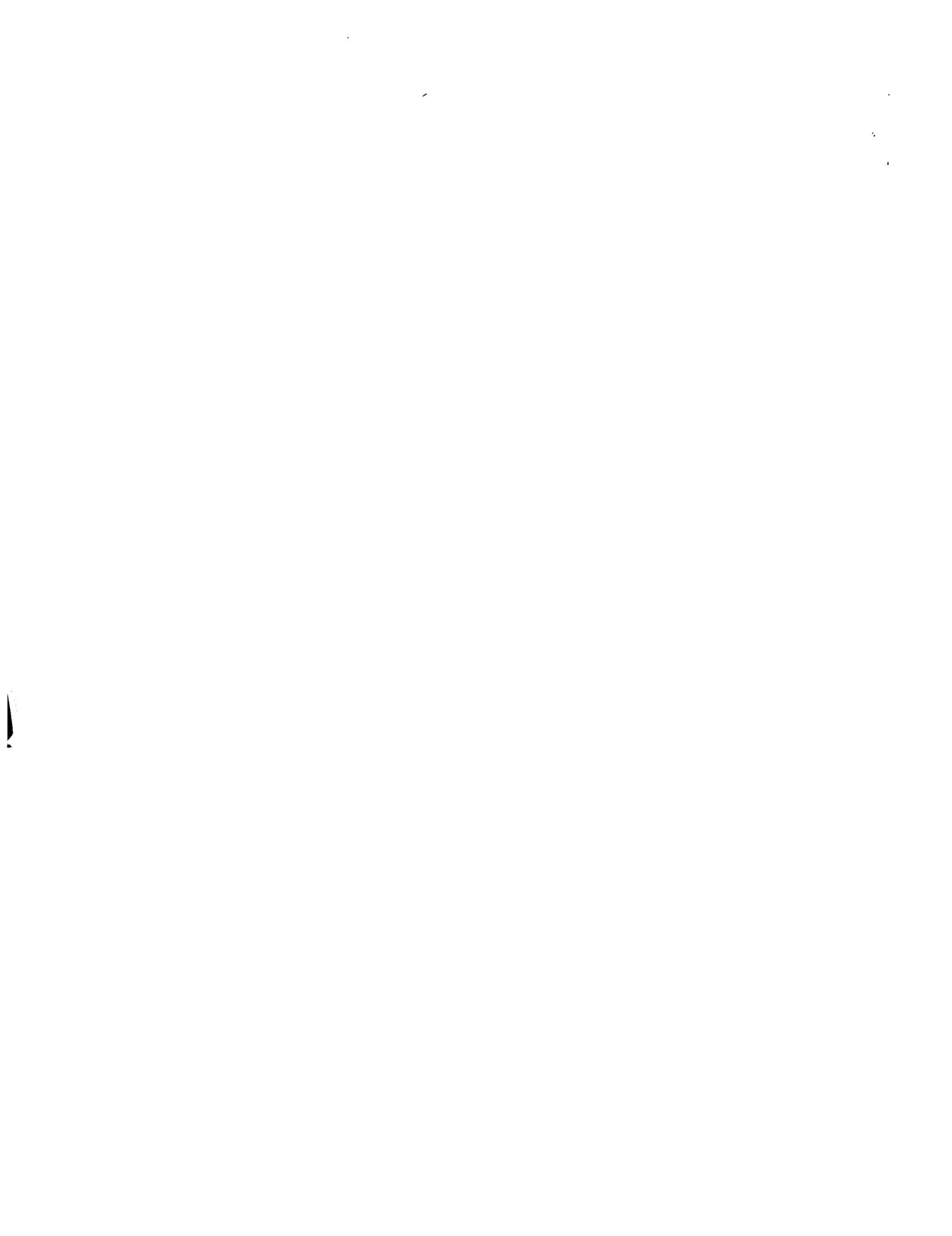
**LETTER REGARDING SUBMISSION OF PRIORITY DOCUMENT**

The above referenced application claims priority from Great Britain patent application GB 0002081.8, filed January 28, 2000. Applicant submits herewith a certified copy of the priority application.

Respectfully submitted,

  
John A. Forkert Reg. No. 38,454  
Mayer Forkert & Williams, PC  
200 Executive Dr., Suite 250  
West Orange, NJ 07052

Date: 5-14-01  
Tel: (512) 241-1004  
Fax: (512) 241-1005





INVESTOR IN PEOPLE

The Patent Office  
Concept House  
Cardiff Road  
Newport  
South Wales  
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

Dated 20 MAR 2001





1/77

31JAN00 E509161-1 D02890  
P01/7700 0.00-0002081.8

The Patent Office

Cardiff Road  
Newport  
South Wales  
NP9 1RH

## Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

1. Your reference

SAH01162GB

2. Patent application number  
(The Patent Office will fill in this part)

0002081.8

28 JAN 2000

3. Full name, address and postcode of the or of each applicant (underline all surnames)

Cambridge University Technical Services  
Ltd  
The Old Schools  
Trinity Lane  
Cambridge CB2 1TS  
United Kingdom

Patents ADP number (if you know it)

If the applicant is a corporate body, give the country/state of its incorporation 6956 809001

4. Title of the invention

Atmospheric Content Detection

5. Name of your agent (if you have one)

Gill Jennings &amp; Every

"Address for service" in the United Kingdom  
to which all correspondence should be sent  
(including the postcode)Broadgate House  
7 Eldon Street  
London  
EC2M 7LH

Patents ADP number (if you know it)

745002 ✓

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number  
(if you know it)Date of filing  
(day / month / year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing  
(day / month / year)8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if  
a) any applicant named in part 3 is not an inventor, or  
b) there is an inventor who is not named as an applicant, or  
c) any named applicant is a corporate body.  
See note (d))

YES



Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form.  
Do not count copies of the same document

Continuation sheets of this form

Description	7
Claim(s)	0
Abstract	0
Drawing(s)	6 + 6

*[Signature]*

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for preliminary examination and search (Patents Form 9/77)

Request for substantive examination (Patents Form 10/77)

NO

Any other documents  
(please specify)

11. For the applicant

Gill Jennings & Every

I/We request the grant of a patent on the basis of this application.

Signature

*[Signature]*

Date

28 January 2000

12. Name and daytime telephone number of person to contact in the United Kingdom

HALEY Stephen

020 7377 1377

**Warning**

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

**Notes**

- If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.
- Write your answers in capital letters using black ink or you may type them.
- If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.
- If you have answered 'Yes' Patents Form 7/77 will need to be filed.
- Once you have filled in the form you must remember to sign and date it.
- For details of the fee and ways to pay please contact the Patent Office.



ATMOSPHERIC CONTENT DETECTION

This invention relates to devices for the detection of atmospheric components.

5 In recent years, with increased concern in relation to environmental issues, more and more emphasis has been placed on the ability to provide accurate and cost effective measurement devices and methods for the detection of particular contaminants and general components in the 10 atmosphere.

One way of detecting atmospheric composition up to high altitudes is to attach sensors to a helium filled weather balloon and to launch the balloon into the atmosphere. The sensor then transmits data, usually via a 15 radio link, as the balloon passes up through the atmosphere. The fact that the sensor is attached to a balloon places severe restrictions, in terms of weight and cost on the sensor design. The cost aspect can be particularly critical, because generally such sensors have 20 to be treated as disposable, given that they may be difficult to locate once they fall back to the ground. All of this can make it extremely difficult to produce a sensor which provides appropriately accurate readings that are 25 continuous throughout the ascent of the balloon and which is capable of resisting the effects of high altitude and low temperature, where contaminants such as rain ice can affect sensor output.

Current systems usually use a pump to draw air into a sensing arrangement. The pumps are expensive, relatively 30 heavy and require considerable power to operate, increasing overall device weight.

Furthermore, with such sensors it can often be difficult to provide accurate readings because it is difficult to determine exactly the rate at which 35 atmospheric air is flowing over the sensor.

A further problem associated with sensors, both those which are ground based and which are drawn up through the

atmosphere, is that it is often difficult for them to detect reliably and accurately certain contaminants for components of the atmosphere that are of particular interest. Particularly, there are certain contaminants, such as ozone, NO and NO<sub>2</sub>, for which there is a keen interest in obtaining accurate readings, but for which the necessary sensing circuitry is expensive and not particularly accurate.

5 The present invention seeks to provide sensing devices which overcome some of the above problems.

10 According to the present invention there is provided a sensor for detecting components in atmospheric air as the sensor is drawn up through the atmosphere, the sensor comprising:

15 a sensor element;  
shielding means for shielding the sensor element from direct contact with air flow as the sensor is drawn through the atmosphere; and  
means for diverting air through the shielding means and over the sensor element as the sensor passes through the atmosphere.

20 The means for diverting air may comprise a hollow cylinder comprising a flow restricting member for diverting air that flows through the hollow cylinder in use into the shielding means. Alternatively, the diverting means may comprise a Venturi flow generating cylinder, which generates a pressure differential across the shielding means and draws air through the shielding means and into the cylinder in use.

25 According to the present invention there is also provided a sensor comprising:

30 a sensor element;  
means for determining the temperature of the sensor element; means for providing heat energy to the sensor element; and means for calculating the air flow across the sensor element by employing the output of the sensor element temperature detecting means and the heat energy

input detecting means and providing an output related thereto.

This second embodiment of the invention may be combined with the first embodiment in order to determine 5 the flow of air directed into the shielding means.

Examples of the present invention will now be described with reference to the accompanying drawings, in which:

10 Figure 1 is a schematic cross-sectional diagram of a first example of the present invention;

Figure 2 is a schematic sectional view of a second example of the present invention;

15 Figure 3 is a schematic cross-sectional view of a third example of the present invention;

Figures 4a and 4b are graphs showing a time dependence of concentrations of NO, NO<sub>2</sub> and O<sub>3</sub> during photolysis in air for differing concentrations of a NO<sub>2</sub>;

20 Figures 5a and 5b show the effects of NO<sub>2</sub> concentration on O<sub>3</sub> production after photolysis; and

Figure 5 is a schematic side view of a sensor according to the present invention.

Referring to figure 1, a sensor 1 according to the 25 invention is configured to be attached to a weather balloon (not shown) so that, in use, it can be drawn up through the atmosphere by the weather balloon. The arrow in the diagram indicates the direction of air flow through the sensor 1 when in use. The sensor 1 has a cylindrical member 2 which has a shape such that its diameter in its 30 central portion is less than that at either of its ends. Such a configuration generates, in use, a regions of low pressure in the central narrow region of the cylindrical member 2. In the central region is positioned a sensor 35 element 3 and a shield member 4 which protects the sensor element 3 from damage due to hailstones, heavy rain, etc during use of the sensor 1. The shield 4 is arranged such

that it connects to the central region of the cylindrical member 2. In use the low pressure region generated in the cylindrical member 2 draws air into the shield 4 and over the sensor element 3. In this example the sensor element 3 is configured to detect ozone but it is possible to detect other atmospheric matter also.

Figure 2 shows second example, in which components corresponding to those in figure 1 are numbered identically. In this example a constricting member is provided at what is, in use, the lower end of cylindrical member 2. The constriction has a narrow opening 8 to allow particles such as rain and ice to fall out of the cylindrical member 2, but which is narrow enough to direct air through the shield 4 and over sensor 3.

Figure 3 shows a detail of a sensor element 3 in a shield 4. In this example the air flow over the sensor element 3 may be generated by a device shown in figures 1 or 2 or by more conventional positioning of the sensor element within a known sensor device. It does, however, have particular benefits in the configuration shown in figures 1 and 2.

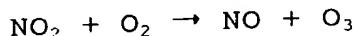
In this example the sensor element 3 is supported by electrical connecting wire 6 which connects to a sensor driving and monitoring device 7. The wires provide electrical energy to a heating element (not shown) on the sensor 3 or adjacent to the sensor element 3 itself, causing the sensor element 3 to be heated. Airflow over the sensor element 3 when the sensor 1 is in use cools the sensor element 3 and the actual temperature of the sensor element 3 can be determined by a temperature sensor (not shown). The output of the temperature sensor, together with the electrical energy input to heat the sensor element 3 is determined by the sensor element driving means 7 and used to calculate the air flow over the sensor element 3.

This air flow data is useful in determining operating parameters and to increase the accuracy of the sensor 1.

Referring to figure 6, a sensor 10 according to a further example of the present invention has an inlet 11 into which atmospheric air is drawn in use. The inlet 11 is connected to a chamber 12 which is incased in internally reflecting material 13, such as metal foils. Through the sensor of the chamber 12 there is positioned a UV light source 14, which maybe a standard UV lamp or other lower power UV light source. The chamber 12 is also connected to a sensor element 15 which is connected via wires 18 to electrical processing circuitry. Furthermore, the chamber 12 is connected to a pump (not shown) by an outlet 16 so that, in use, the pump can be employed to draw atmospheric air in from the inlet, through the chamber 12 and pass the sensor 15. A light trap 17 is provided to prevent light from the UV light source 40 reaching the sensor element 15 and generate spurious readings.

In use the sensor 10 is operated to draw a sample of air through the chamber 12 and past the sensor 15 and the level of ozone present in the air is detected. The UV light source 14 is then turned on.

The presence of a UV light source in the chamber 12 alters the equilibrium point of the equation:



urging it to the right and increasing the amount of ozone in the chamber 12 and hence as detected in the sensor 15. Provided that the chamber 12 is sufficiently long and the amount of UV light produced by the source 14 is sufficiently large, together with appropriate control of airflow, the ozone level detected by the sensor will increase to a peak related to the concentration of  $\text{NO}_2$ .

5 present. Of course, operation of the sensor 10 in this manner is dependent upon the amount of ozone being drawn in through inlet 11 being constant throughout the measuring process. In practice this may not be the case, and it may be preferable to provide a further ozone sensor (not shown) at the inlet 11, so that a difference between inlet ozone and outlet ozone can be determined and this difference employed to measure the  $\text{NO}_2$  present.

10 15 Figures 4a and 4b show the level of ozone and  $\text{NO}_2$  present and detected by a system according to the present invention. In figure 4b ozone has been removed from the sample that is drawn into inlet 11, and it can be seen that the level at which the ozone settles to a steady state is proportional to the level of  $\text{NO}_2$  present in the sample therein.

20 25 The time taken to reach the equilibrium state of the equation listed above is also affected by the concentration of NO in the sampled air. For this reason, by providing a sensor 10 with appropriate sensitivity, it is also possible to determine the concentration of NO in the air drawn in through inlet 11 during provision of UV light by UV light source 14. It has been determined that the rate at which the level of ozone reaches a steady state during operation of the sensor is indicative of the level of NO present. By determining this rate the sensor can therefore also provide an indication of the level of NO present, given that the level of  $\text{NO}_2$  has been determined.

30 35 It will be appreciated that it may be possible to pre-treat the samples provided to the sensor 10 in situations where it is not necessary to determine the levels of ozone, NO, or  $\text{NO}_2$ , the pre-treatment involving the removal of one or more of these gases. This will simplify the processing of sensor signal output to ensure a higher and faster

accuracy in the measurement of the specific gas of interest.



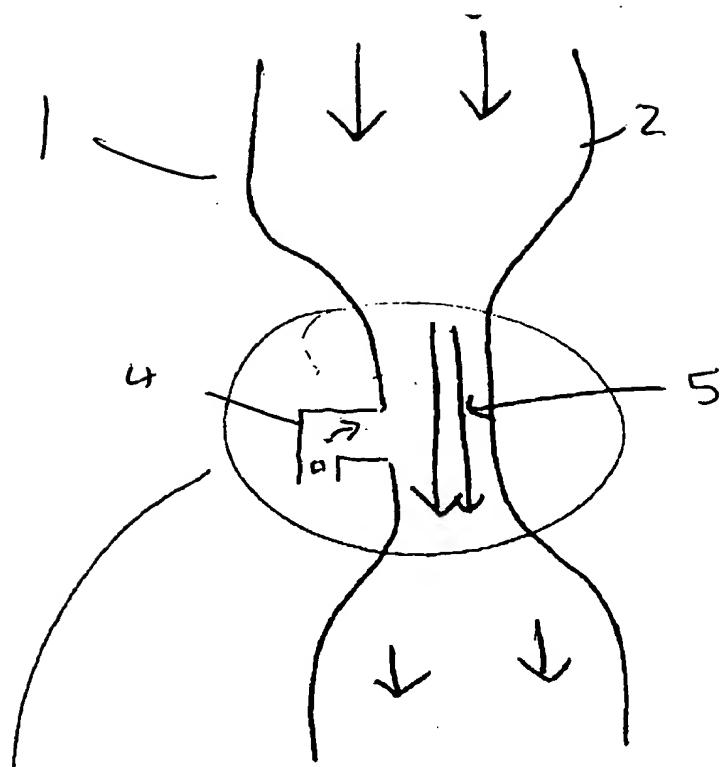
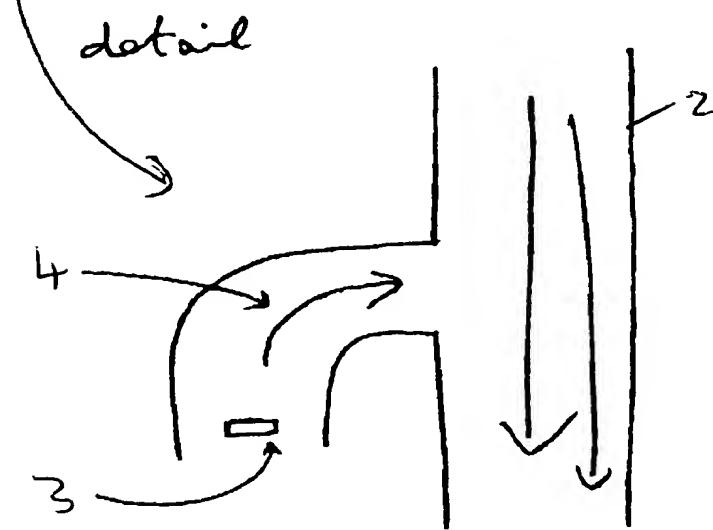


Fig 1





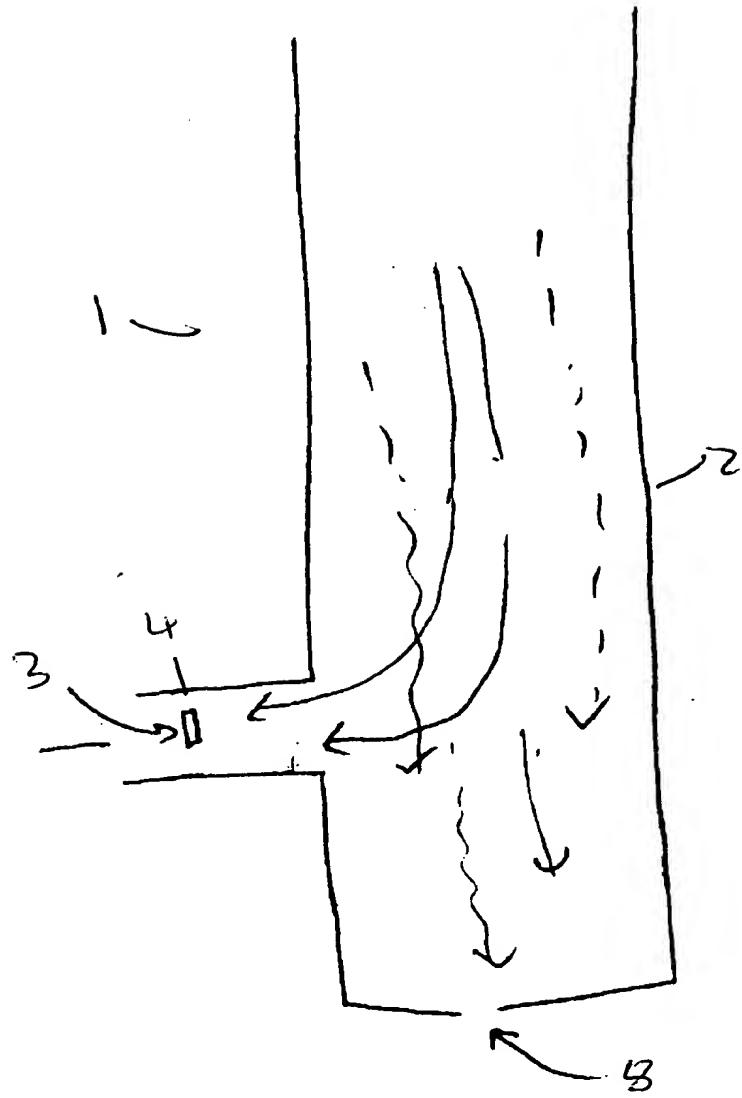


Fig 2



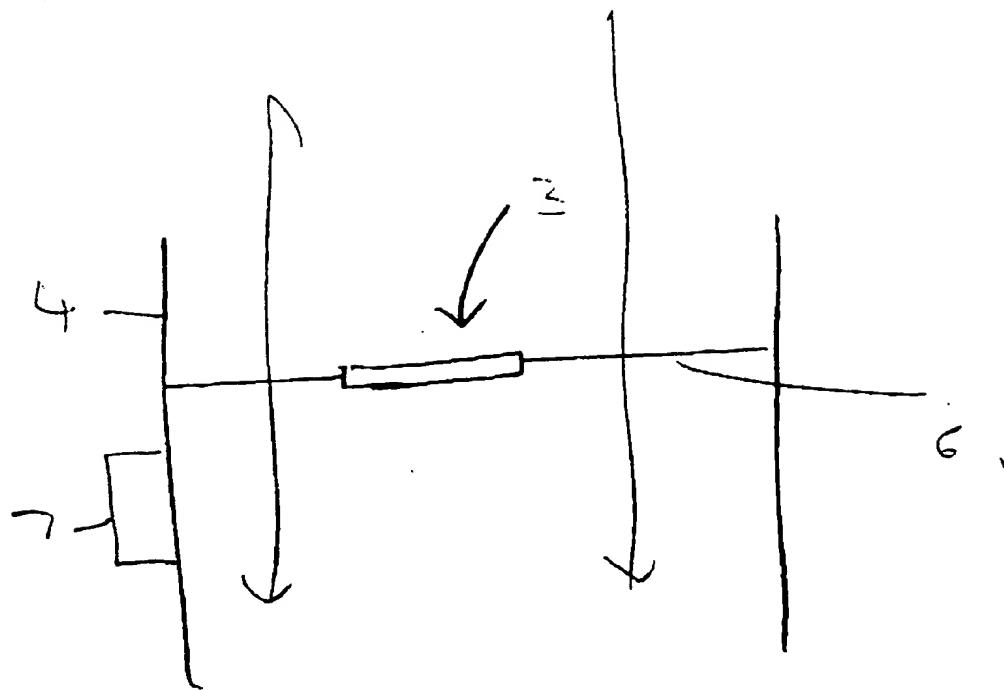
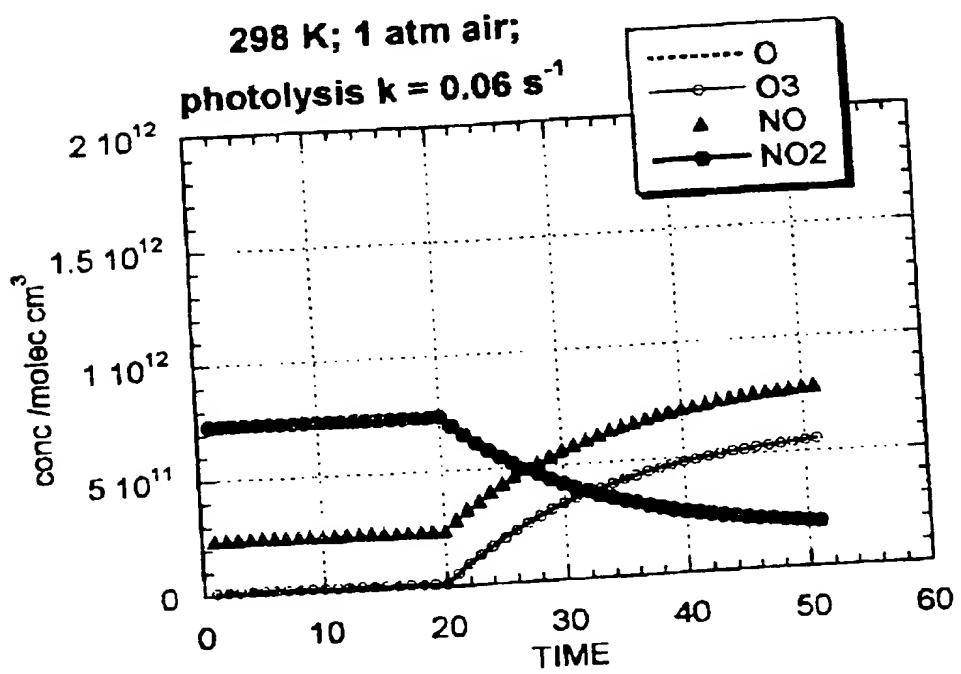
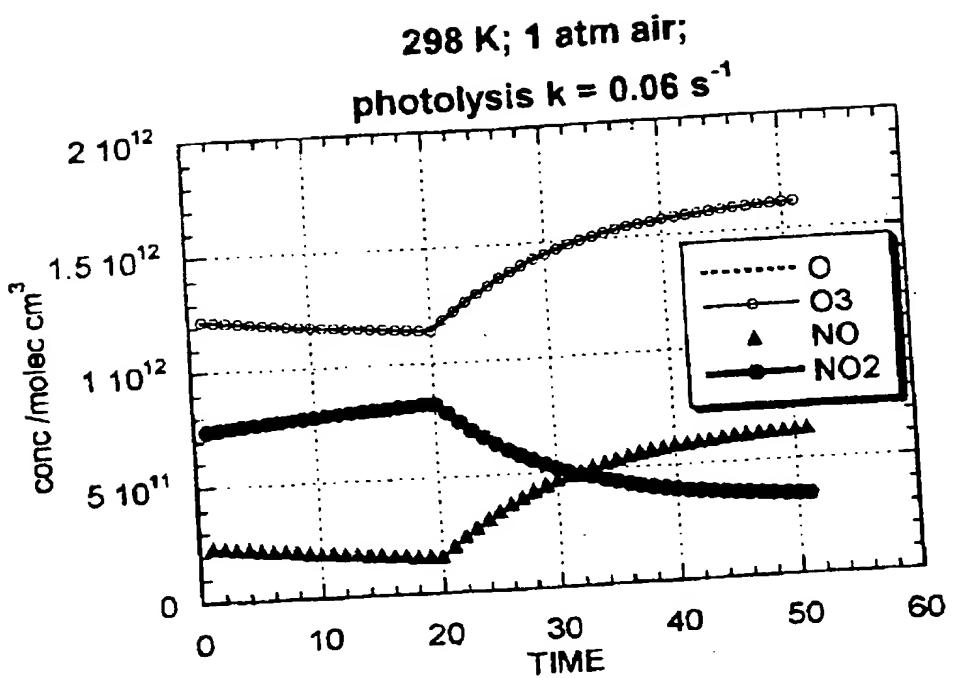


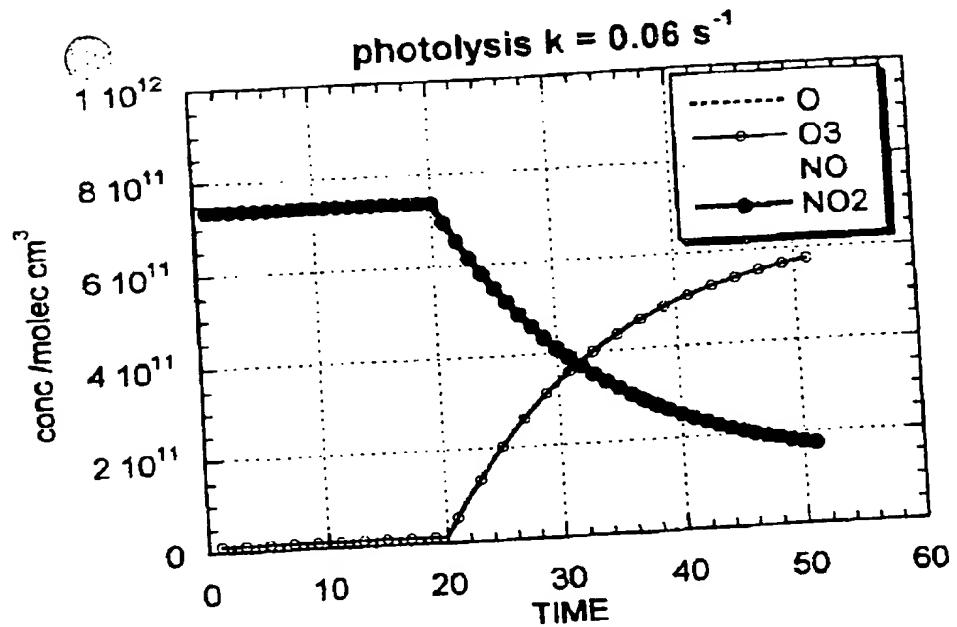
Fig 3



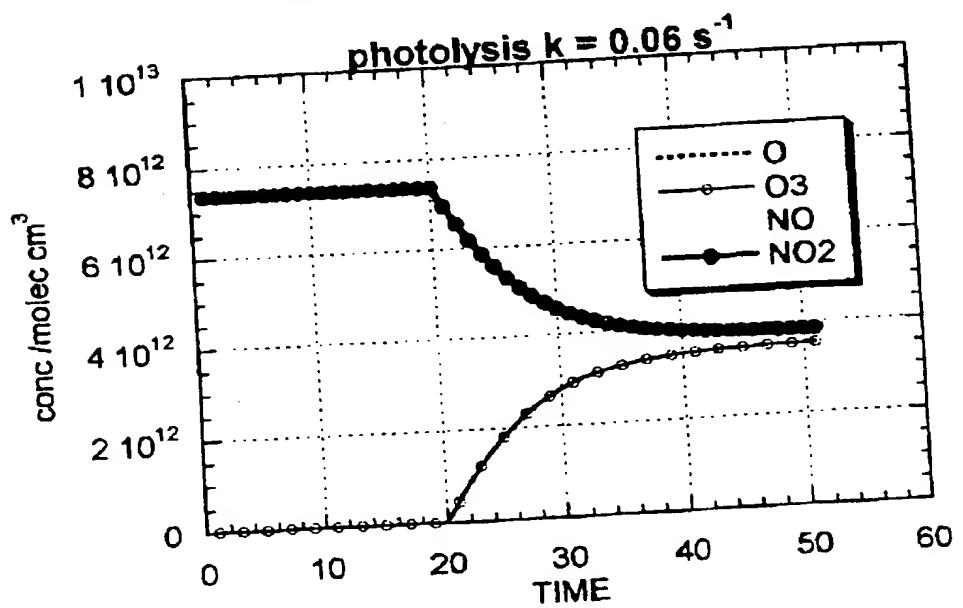




298 K; 1 atm air; 30 ppb  $\text{NO}_2$



298 K; 1 atm air; 300 ppb  $\text{NO}_2$





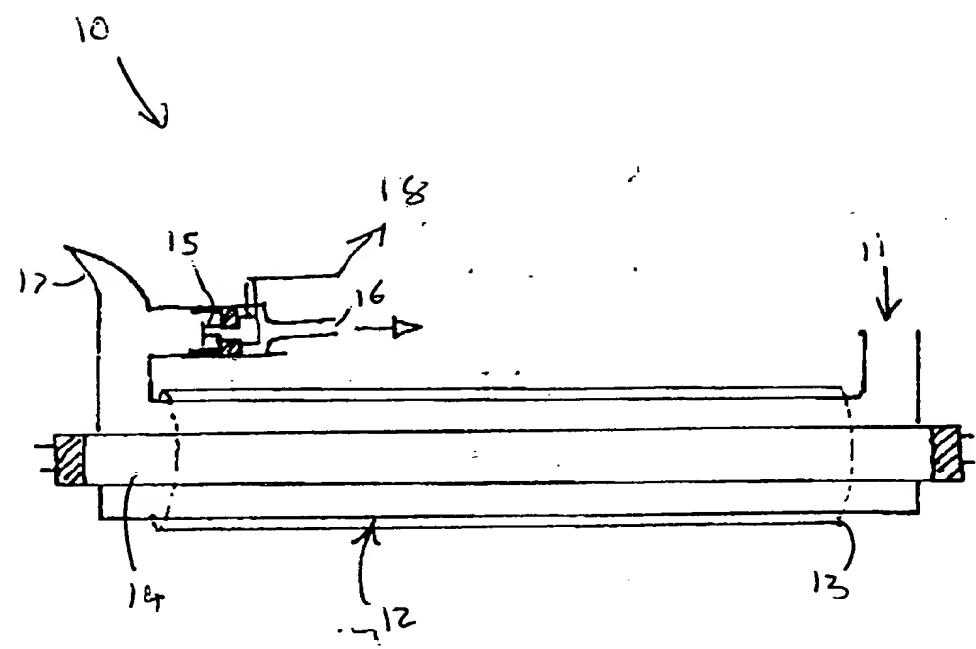


Fig 6

